

SHOP ORGANIZATION AND MILLWORKING

LEARNING OBJECTIVE: *Determine the requirements necessary to lay out and operate a builder's shop safely. Recognize and explain the procedures in developing good millworking techniques and be able to lay out, construct, and install cabinets.*

As a first class or second class petty officer, you will at some point in your naval career be in charge or supervise a shop. You maybe tasked to plan the layout of equipment and materials needed to set up a new shop from scratch. In doing so, you will find that certain factors that are applicable in setting up a new shop are also applicable when taking over as a supervisor of a shop already in existence.

SHOP ORGANIZATION

Where there are Seabees, there is likely to be some sort of builder or maintenance shop. When taking over a shop already setup, you may often find it worthwhile to make a study of the layout of equipment and materials to determine if changes could help provide a smoother work flow and higher production.

PURPOSE OF A SHOP

In planning the layout and organization of a shop, you should carefully analyze the purpose of the shop. What kind of work will be done here? How much work must be turned out under normal conditions? Is the shop a specialized shop or a general-purpose shop? Does the shop meet all safety and environmental precautions?

SAFETY will be given top priority. It is strongly recommended that all portions of the area be clearly visible to the instructor and the student. Aisles of travel will be designated by painted lines, and these aisles should be a minimum of 3 to 4 feet in width. Use nonskid flooring in critical areas. Equipment and storage racks must be arranged so the entrance and exit to the building can be kept clear and will be accessible in the event of fire or emergency. Locate

stationary machines so that the moving parts will NOT constitute a hazard to either the operator or to other shop personnel. Be certain that your shop layout will allow easy access to fire-fighting equipment, electrical control panels, and junction boxes. Because safety and environmental requirements change on a continuing basis, we can not cover every aspect to safety in a shop. Refer to the *School Shop Development Manual* by Rockwell Manufacturing Company, the *Navy Occupational Safety and Health Manual*, OPNAVINST 5100.23, and the *Occupational Safety and Health Standards for the Construction Industry, Code of Federal Regulations* (29 CFR PART 1910).

You must also consider the particular advantages and limitations of the proposed shop space. How large is it? How many personnel will be expected to work in the shop at the same time? What kind of tools will be available? Where are the power outlets located? Can good lighting be arranged? What type of ventilation will be readily available?

The function of the shop will have an important bearing on the equipment needed and the minimum space required. At times, you may NOT get the amount of space desired and have to do the best you can with whatever space is available. In some instances, two spaces may be available, but one is unacceptable because of major problems that would be encountered.

ARRANGEMENT OF A SHOP

Good arrangement is required in all shops, regardless of each shop's function. The arrangement of equipment, layout tables, and soon, in a shop should be in the order of the work flow of the project that is most

dominant in that shop. The layout in figure 5-1 maybe used as a guide in laying out a carpentry shop.

In planning the arrangement of equipment, consider such factors as sequence of operations, working space, clear shop entrance and exit, adequate workbenches, and safety. The positioning of equipment, layout tables, and so on, do NOT have to be the same in one shop as in another.

Try to place stationary machines so that the work will flow in an orderly and logical sequence. It is probably easier to do this in a specialized shop than it is in a general-purpose shop where the work differs considerably from one day to another.

In shops where there is a series of operations to be performed, the relative position of the various pieces of equipment has an important bearing on efficient operations. Not only should the equipment be accessible, but it should also be arranged to save wasted motion and to reduce walking distance.

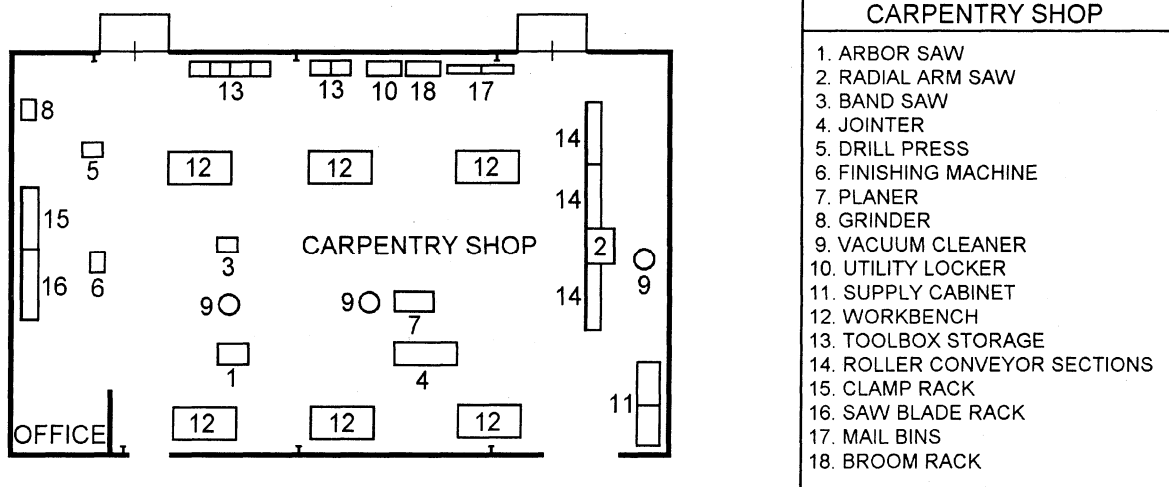
This will enable your personnel to turn out more work when their equipment is close at hand. Clearance between adjacent machines should be such that the operators will NOT get in the way of one another. Electrical outlets should be readily available to the workbenches. Needless delays are caused by having to rig extension cords from poorly located outlets.

Your plans should include adequate means for storing tools and materials. When considerable amounts of materials must be kept on hand and space permits, a special storeroom maybe used for storage of materials. Where desirable, a portion of this storeroom may also be used for storage of tools and equipment. When a storeroom is available, however, it may still be advantageous to store certain material in the shop near the machines or equipment on which it is used. Refer to the *Occupational Safety and Health Standards for the Construction Industry, Code of Federal Regulations (29 CFR PART 1910)* for more information on storage of tools, material, and equipment.

The amounts and types of materials stored in your shop will depend largely upon the space available and the intended purpose of your shop. In most shops, you will probably need facilities for storing such items as bolts, nuts, nails, screws, and paint. Whatever the type of shop, you should make an effort to see that your storage facilities are arranged to give the greatest possible amount of free working space.

FLOOR

In today's industry, concrete is the most widely used flooring material and possibly the most unsatisfactory flooring material for shops. Even when painted or sealed to eliminate dust, the concrete floor is



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Figure 5-1.—Typical layout of a carpentry shop.

still hard and very slippery. This is why nonskid paints are used so extensively.

Wood is the preferred floor material; however, it is the most expensive. Tile floors have become popular recently due to their low initial cost and ease of replacement. Some caution should be exercised in specifying the exact type of tile due to solvents and other inherent damaging effects when used in a shop.

Walls and Ceilings

The WALLS should be made of CMU, tile, or other material that can be easily cleaned and very durable. Windows should be placed as high up in the walls as possible to let natural light in. As a general rule, windows are required to be placed a minimum of 54 inches from the floor. If you want to put an acoustical plaster or other soundproof material on the walls, be sure it is a minimum of 5 feet from the floor. CEILING heights for a shop should be at least 12 feet high. Although cost will be a definite factor, acoustical material or treatment is highly recommended for the ceiling.

Office Space

You will also need space for an office. As a rule, try to locate the office in an area of the shop where you will be least disturbed by noise. The shop layout plan should make provision for a bulletin board upon which safety posters, maintenance posters, instructions and notices, plan-of-the-day, and such other information may be posted, as appropriate.

The bulletin board should be located in a prominent place in the shop, preferably near the entrance where personnel will be likely to pass during the day. If necessary, artificial lighting should be provided so that material on the bulletin board can be easily read. The material posted on the bulletin board should be changed frequently, expired notices promptly removed, current plan-of-the-day posted early, and posters and other material rotated periodically.

MILLWORKING

MILLWORK is shaped items of wood that are made, in most cases, from well seasoned kiln-dried lumber (4 to 9 percent moisture content) that requires manufacturing. Most millwork products are used in the

interior of buildings and is installed by finish carpenters. However, the Builders do various types of construction and the need to understand millwork concepts and construction techniques associated with millwork is essential.

Millworking not only includes interior trim products but, casework, doors, kitchen and bathroom cabinets, window frames and sashes, stairs, furniture, specialized items made to order, and woodwork that is turned. The majority of the millwork in the construction industry is constructed and sold by two methods:

- *Setup* millwork which is assembled and ready to be installed with minimal or no fitting, such as prehung doors, molding, cabinets, and so on.

- *Knocked-down* millwork which is assembled by the Builder on the jobsite, such as window frames, doorframes, flooring products, some furniture units, stairs and accessories, and so on.

Most products are produced in a manufacturing mill or plant and are ready to be installed by fastening to the wall or floor. If the need arises for you to install these types of products, refer to the manufacturer's instructions and/or the plans and specifications.

As the Builder in charge of a shop, you and your crew will be tasked at times to make plaques, flag cases, bookcases, shelving units, and cabinets. Many of these projects you are tasked with will be nothing more than an idea and you will be required to interpret by sketching their idea on paper and developing this idea into a workable drawing.

In the previous BU training manual (TRAMAN), you learned the basic concepts of drawings, interior and exterior trim, and casework mentioned in this section. However, with the large scope of products and changing technology, these products could not be covered sufficiently due to time and space constraints. The next section will cover designing, constructing, and installing millwork products.

CABINETMAKING

Cabinetmaking is primarily used in interior finish carpentry, such as furniture, kitchens, bathrooms, and casework. A&E firms, Builders, or cabinetmakers that specialize in cabinetry, usually plan their cabinetwork

as built-in unit. Floor plans usually show the cabinetwork location, while elevation plans usually provide detailed dimensions, as shown in figure 5-2.

DESIGNING A PRODUCT

Builders are often provided with complete working drawings of a product to be constructed. The drawings usually contain information to build the product, such as size, style, material, construction, and finish. Sometimes the Builder must design, sketch, and make a working drawing from the customer's verbal specifications or from simple line drawings. To make a working drawing from the incomplete instructions supplied by the customer, the Builder must

1. know the principles of good cabinet design;
2. be familiar with popular cabinet styles;
3. develop a sketch that meets the customer's specifications and conforms to good design principles;
4. make a working drawing from the sketch in order to build the product.

When designing a product, you must consider the purpose, strength, size-shape proportion, appearance, time, and cost of the product. The time designing helps avoid mistakes and saves time in the long run. One of the most important considerations in designing a product is its purpose. A product's purpose maybe the

deciding factor in determining the design. For example, a bookcase must be the proper size and strength to hold the desired quantity and kind of books. Cabinets and furniture are usually make only strong enough to fulfill their purpose. The strength required of a object may determine such things as the type of joint, the size, and the kind of wood. It is often better to use strong woods like oak, ash, or maple to give the strength required by a product. Oversized softwood, like pine, may also be used. However, using oversize parts gives a massive and awkward appearance to a product.

Some furniture and cabinets must be built to standard sizes in order to serve its purpose. A dining table that is too low will not serve its purpose. A kitchen cabinet counter top that is too narrow will not accommodate a sink. In addition to size and shape, the designer must also consider proportion. The proportion of a cabinet is the relationship between its dimensions which include its width, height, and length. Some proportions are more pleasing to the eye than others.

The appearance of a cabinet maybe largely due to its purpose, location, and finish. If the product is to be painted, a less expensive material maybe used. If it is stained with a clear finish, a better quality material should be used. The appearance of cabinet doors may be changed by cutting shapes in doors instead of solid doors. The edges of the doors may be lipped or cut square according to the appearance desired.

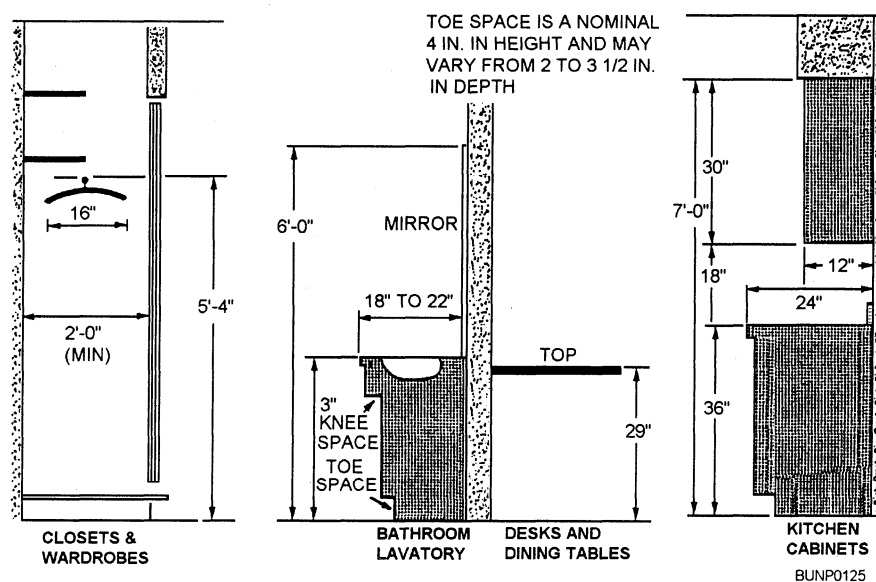


Figure 5-2.—Typical dimensions for cabinetwork.

One of the important considerations in designing cabinetwork is the time required to construct it. Time may affect the type of joint, kind of material and fasteners, method of construction and kind of finish. To save time, you may use a butt joint reinforced by corrugated fasteners instead of the more complicated and time-consuming mortise-and-tenon joint. To save time, you may use nails instead of screws, or a quick-drying sprayed finish may be selected.

The quality of the finished product is also a factor in designing. High-quality products take more time and cost more to construct. The Builder must decide the minimum quality level that will be accepted and produce it at minimum cost.

Making a Sketch

A sketch is a free-hand drawing which lets the designer experiment with the elements of a design. It is the preliminary step to a working drawing. The first step in designing and building an object is to make several drawings to experiment with design, size, and proportion. After the design and size have been determined, next determine the type of wood to be used, the finish, and the construction details, such as joints, style (Early American, traditional, contemporary, and so on), location, and type of fasteners. Different kinds of drawings may be used according to which best illustrates the information, such as perspective, orthographic projection, pictorial or exploded (fig. 5-3),

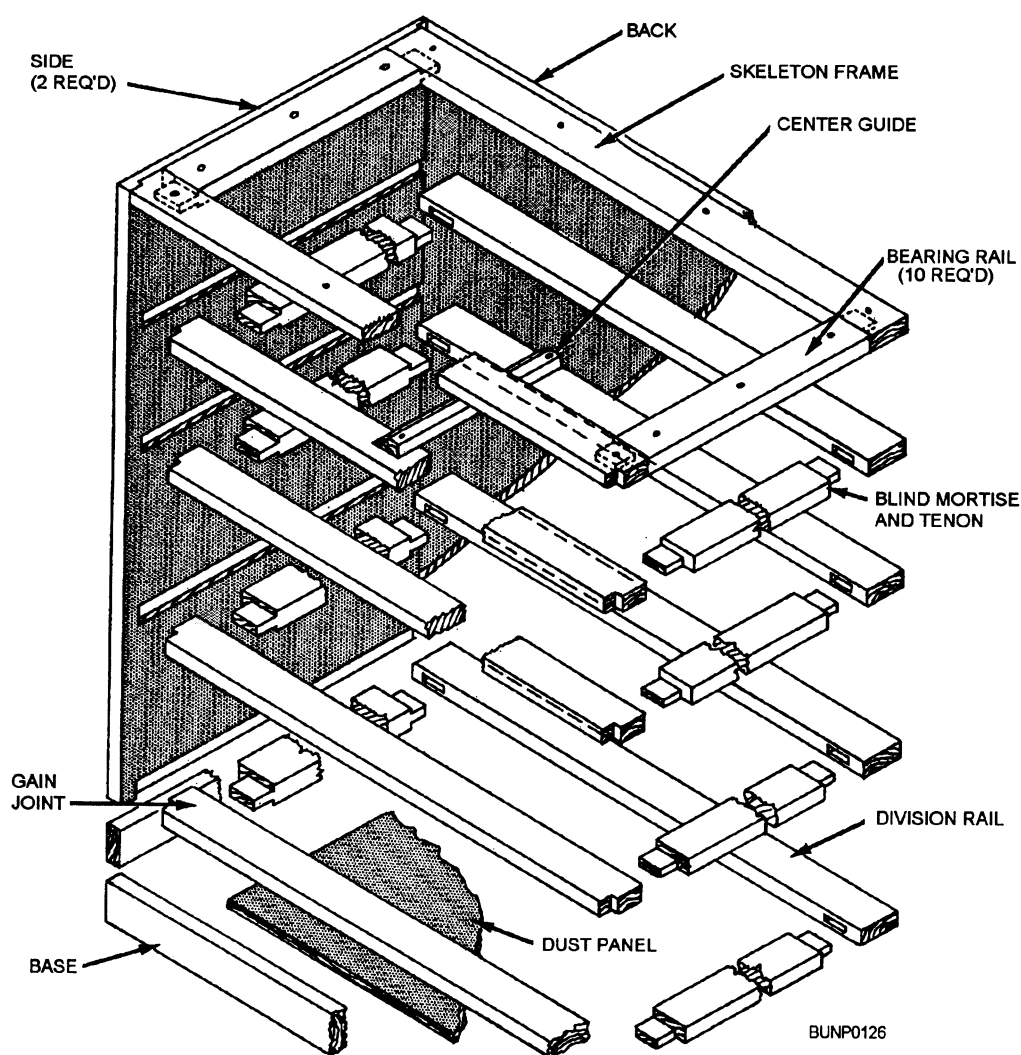


Figure 5-3.—Exploded drawing and nomenclature of a cabinet.

and/or detailed drawing. Refer to the *Architectural Graphics Standard (AGS)* for complete information on these kinds of drawings.

Working Drawings

When enough sketches have been made, the ideas developed are put into the form of working drawings. A working drawing is one made with drawing tools,

such as a T square, triangle, or compass. It is drawn to exact scale (fig. 5-4). It provides most of the information required to build the object. Some features, like the type of joint, glue, or fasteners, are left to the discretion of the Builder however.

When working drawings are developed, drafting standards are followed closely. The drawing should be centered on the page. Lines should be standard weights. The drawings should be adequate dimensions and

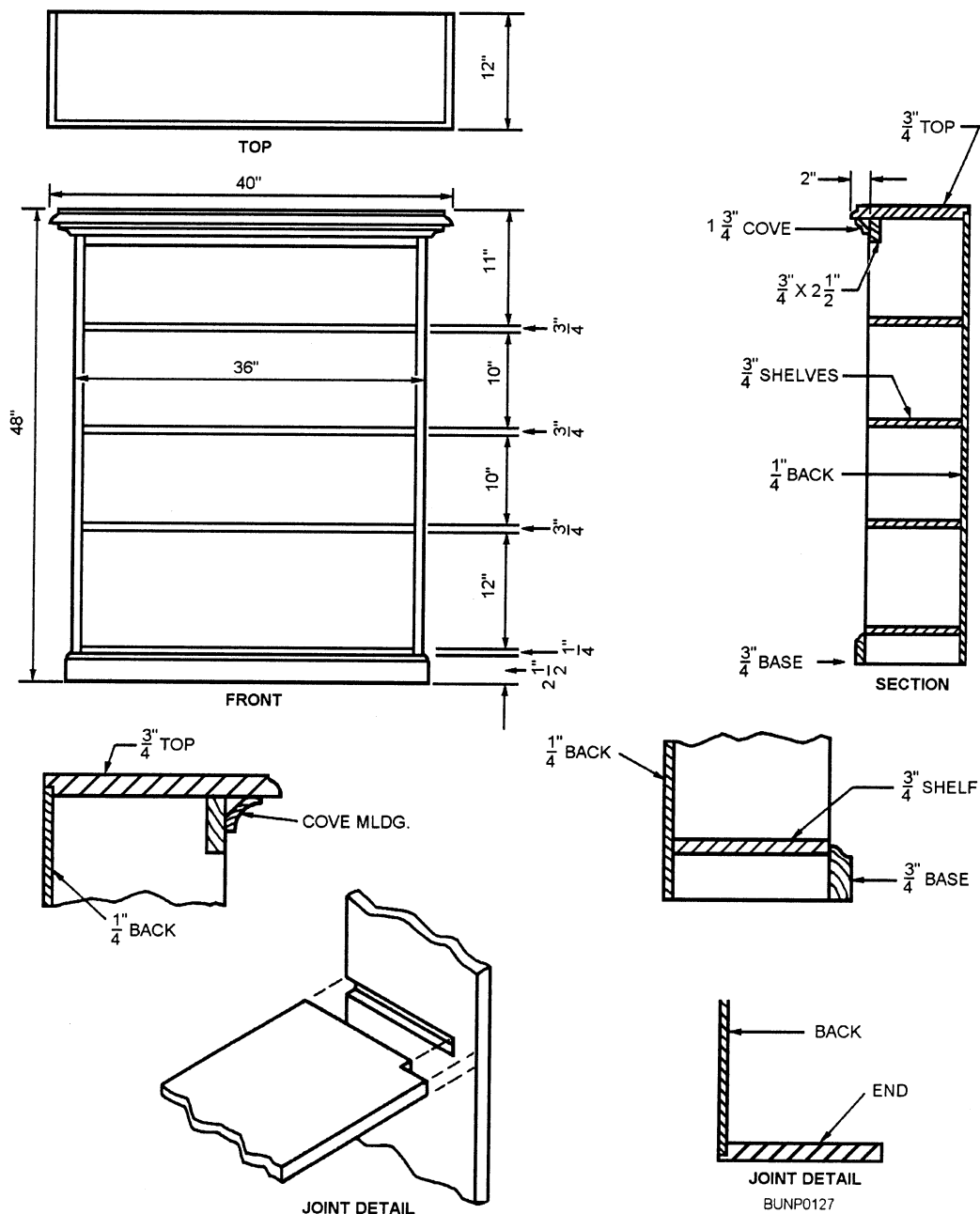


Figure 5-4.—A working drawing of a bookcase.

include all necessary notes. Lettering should be neat and legible.

PLAN AND LAYOUT

After the working drawings are completed and approved, a plan and layout of procedures are done. This saves time and eliminates mistakes. A good cabinetmaker will always lay out and plan the work before starting to build. A number of construction problems are solved during this planning period. With a good layout and plan, those who do the work have few questions.

Layout Rod

One of the most common ways to lay outwork is to use a rod. A rod is normally a 1-inch x 2-inch strip of lumber which indicates the actual location of all the parts of the cabinet. One side of the rod is used for marking the width. Another is used for marking the height, the third side is for the depth, and the fourth side is used if other cabinets are to be built that differ in only one dimension. This technique is similar to laying out studs on a floor in rough framing. The rod shows the locations where the cuts would be—the drawers, the shelves, the rails and stiles—any detail it takes to construct a cabinet. Cabinetmakers use different techniques and methods in developing these rods and making a layout rod more easier to read.

Making a Cutting List

Once the rod layout is complete, all measurements for cutting the stock should be taken from it. A cutting list can then be made listing all the parts and sizes. A cutting list must include the quantity of each component, the thickness, width, and length of stock, exact cut of each component, and should include the type of joint for each component.

Developing a Plan of Procedure

A plan of procedure must be developed before making a piece of cabinetwork. This involves writing down all the steps of construction.

The complexity of the work may determine the order of the steps to be taken to complete a job. In most cases, the following order should be used:

1. Make a layout rod from the sketch or drawing. However, many Builders or cabinetmakers bypass this step due to their experience in cabinetry.

2. Make a cutting list, using the measurements obtained from the layout rod and drawings.

3. Select the right type of stock for the project; then cut the stock to rough lengths. Rough length is 2 or 3 inches longer than actually required. Cutting to rough lengths makes handling the stock easier and facilitates machining.

4. Face one side of the stock. Facing produces a straight surface and eliminates any cup, bow, or twist.

5. Plane the stock to thickness. This is the first step to bring the stock to size. Make sure all parts are planed at the final setting of the planer to ensure equal thicknesses.

6. Joint one straight edge on each piece. This straight edge will be held against the fence of the table saw for ripping to width.

7. Rip the stock to the required width. Use the correct saw blade for the smoothness of the edge desired. Rip all pieces of the same width without changing the setting of the rip fence.

8. Cut the stock to the overall length. This is the last step in cutting the pieces to their overall finished size. Use a stop block to cut equal lengths.

9. Make rabbets, dadoes, mortises, tenons, and bore holes; and perform other machining as necessary. Set up machinery and make all similar cuts without changing the setup.

10. Sand the inside faces before assembling. Once you assemble the inside of a cabinet, it is difficult to sand. These surfaces must be smoothed before assembling.

11. Assemble the parts. When possible, assemble the parts using only clamps (no glue or fasteners) to check the quality of fit. Then assemble the piece permanently as required. After assembly, wipe off any excess glue that may make finishing difficult.

12. Prepare exterior surfaces for finishing by sanding if the exterior surfaces were not sanded before assembly. Handle the pieces carefully to avoid marring the finished surfaces.

13. Apply the finish. The finish may consist of filling, staining, and applying clear or pigmented coatings.

14. Install the necessary hardware. Hardware is often installed before finishing; then remove and replace after finishing. If there is no danger of marring

finish, the hardware is installed after finishing. The finish is not usually applied to the hardware.

CASEWORK CONSTRUCTION

“Casework” is defined as boxlike components of cabinetwork, normally rectangular. Casework may contain shelves or drawers for storage. Doors or covers are sometimes fitted to enclose the storage space. Examples of casework are bookcases, chests, desks, display cases, and kitchen cabinets. Casework consists

of a skeleton frame, face frame, two ends, legs, and the bottom back and top (fig. 5-5).

Skeleton Frames

The skeleton frame is made to fit in the interior of the case. It consists of stiles (vertical members) and rails (horizontal members) only. Panels fitted into the frame are called dust panels. The skeleton frame serves a number of purposes:

- It provides a means of fastening the case top to the case and holding the ends together at the top.

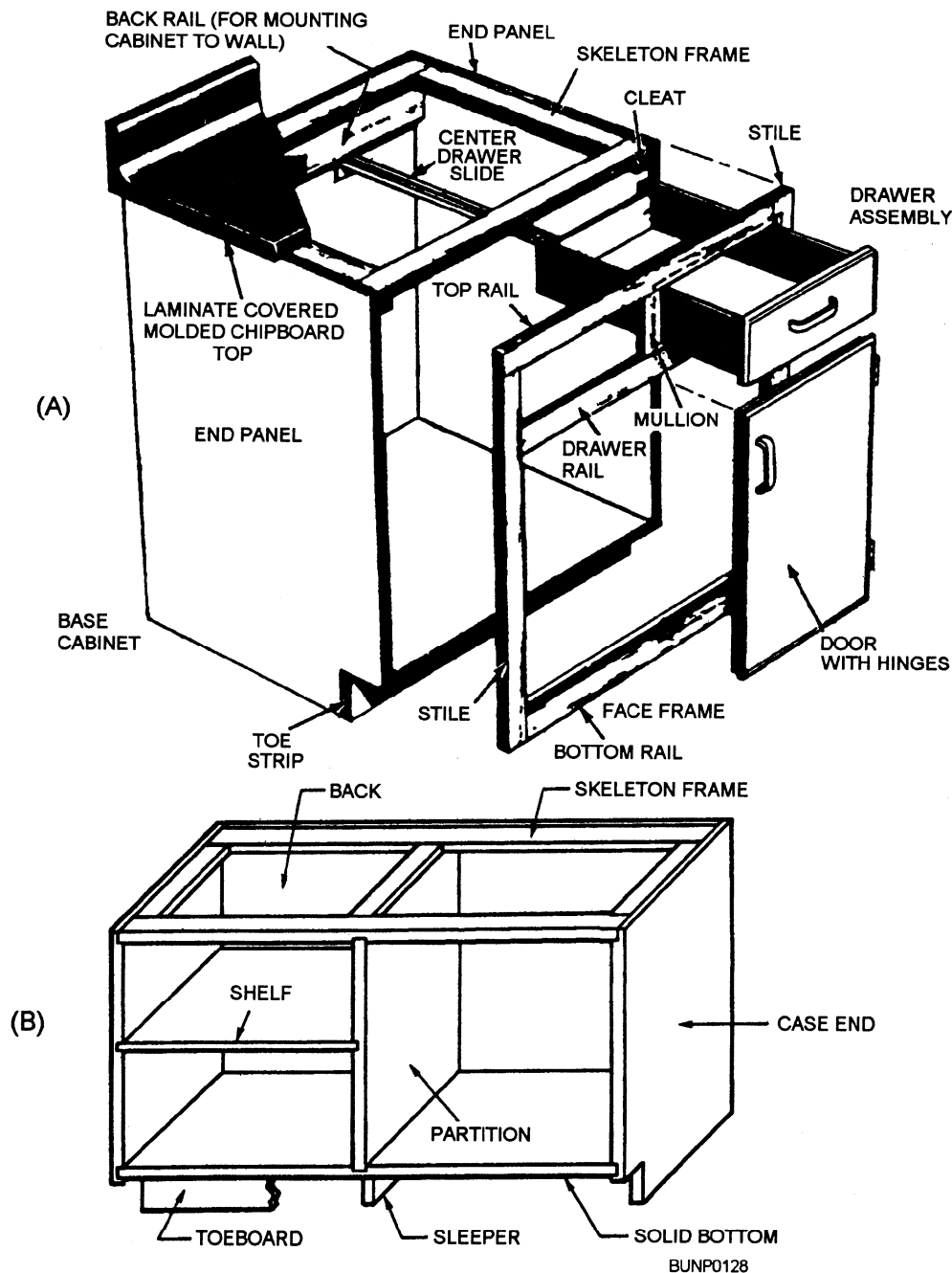


Figure 5-5.—Typical case construction.

- It fastens and holds the ends together at the bottom.

- It separates and supports drawers.

- It is used vertically as divisions when solid partitions are not required.

Skeleton frames are assembled before being installed in the case. Dowels, biscuit joint, or mortise-and-tenon joints are recommended joints used to make a skeleton frame.

ENDS.— The case ends are made of solid edge-glued lumber or plywood. They may also be paneled frame with stiles and rails and plywood or hardboard panels. Paneled ends are made similar to paneled doors using either doweled or mortise-and-tenon joints.

The back edge is usually rabbeted to receive the cabinet back. If the case is to be fitted to the wall, the rabbet is cut deep to recess the back and allow the projecting material to be scribed to the wall.

The front edge is joined to the face frame with a butt, rabbeted, or mitered joint. If a butt joint is used, the front stile of the case end is made narrower than the back stile because of the thickness of the face frame.

Case ends may also be dadoed to receive the top, bottom, fixed shelves, skeleton frame, and dust panels of the case.

LEGS.— Sometimes the stiles of the case ends extend below the bottom and act as legs. The front stiles of the ends also act as a stile for the front frame. In this type of construction, it is usual for the skeleton frame to

be notched around the leg. It then extends to the front and becomes the face frame and dividing rails for the drawers.

PARTITIONS AND SLEEPERS.— Partitions are vertical members dividing the interior of the case into sections. They tie the top and the bottom of the case together and are usually dadoed into the top and bottom. The skeleton frame, dust panels, and shelves are cut in between the partitions and are usually dadoed into the partitions. Partitions are also known as divisions or standards.

Sleepers extend from the bottom of the case to the floor and are located directly under the partitions. They provide support of the case to the floor and keep the bottom from sagging.

SHELVES.— Shelves must be strong enough to support the weight placed on them. They must also be wide enough and correctly spaced for their intended purpose. Shelves may be made of solid wood, plywood, particle board, or glass.

Bookcase shelves should be from 8 to 10 inches wide and spaced 10 to 14 inches apart. The length of a 3/4-inch-thick shelf should be no more than 36 to 42 inches without intermediate supports. Supports should be spaced close enough to keep shelves from sagging under the weight placed upon them.

One way of increasing the strength of a shelf is by installing strongbacks. A strongback is a strip of wood screwed on the edge to the underside of the shelf. It is placed either on or near the front or back edge of the shelf or both edges of the shelf.

Fixed shelves are usually dadoed in or supported on wood cleats (fig. 5-6). A cleat is a small strip of wood

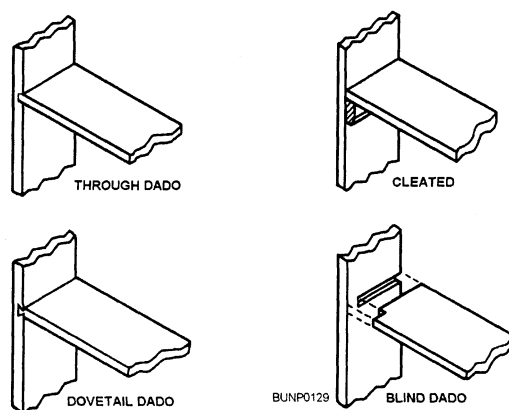


Figure 5-6.—Fixed shelf construction.

screwed to the inside of the case to support the shelf. A through dado or dovetail dado maybe used to support a shelf. A better method is to use a blind dado to conceal the joint.

Adjustable shelves may be supported with metal shelf standards and clips that are either surface-mounted or set flush in grooves. A pair of notched and numbered standards supports the shelves at both sides of the case. They are fastened 1 to 2 inches in from the back and front edges. When they are installed, the same number appears right side up at the bottom of all four standards. The clips can then be inserted in the correct notch, so the shelf lies flat.

Another method of supporting adjustable shelving is by inserting wood dowel pins or commercial shelf pins into four holes at each shelf location. Two vertical rows of equally spaced, 1/4-inch holes are drilled on either side of the case about 1 to 2 inches in from the front and back edges. The holes are spaced approximately 2 inches apart for ordinary work. The holes should be drilled deep enough, so the pins will not fall out when the shelf is placed upon them.

Adjustable shelves are sometimes installed by using ratchet strips. Ratchet strips are strips of wood with notches cut at equal intervals on one edge. These strips are fastened to the front and back edges of the case on the inside. A ratchet cleat is cut to length with ends matching the notches to fit in between the ratchet strips. The ratchet cleat may be moved to any notch to support the shelf.

Another method of making ratchet strips is by boring a series of equally spaced, 3/4-inch holes along strips of 1-inch by 4-inch lumber. The strips are cut in half along the center lines of the holes. Ratchet cleats with rounded ends are then cut to match the ratchet strips.

BOTTOMS AND TOEBOARDS.— The bottom of a case is usually made of solid lumber, particleboard, or plywood, unless a dust panel is used when a drawer is supported by the bottom. Case bottoms are sometimes raised above the bottom rail of the face frame to act as a stop for doors. Another design eliminates the bottom rail of the face frame. The door or drawer then covers all of the bottom edge which also acts as a stop.

To cover the space between the bottom and the floor and to provide toe clearance, install a toeboard. The toeboard is usually set back from the face of the case 2 1/2 to 3 inches.

Cabinet Facing

After completing the frame construction and shelving, apply finished facing strips to the front of the cabinet frame. These strips are sometimes assembled into a framework (called a faceplate or face frame) by commercial sources before they are attached to the basic cabinet structure. The vertical members of the facing are called stiles, and the horizontal members are known as rails.

As previously mentioned for built-in-place cabinets, you cut each piece and install it separately. The size of each piece is laid out by positioning the facing stock on the cabinet and marking it. Then the finished cuts are made. A cut piece can be used to lay out duplicate pieces.

Cabinet stiles are generally attached first, then the rails (fig. 5-7). Sometimes a Builder will attach a plumb end stile first, and then attach rails to determine the position of the next stile.

Use finishing nails and glue to install facing. When hardwoods are being nailed, drill nail holes where you think splitting might occur.

Face Frames

Face frames are preassembled units, usually joined with dowels, biscuits, or mortise-and-tenon joints, into which drawers and doors are fitted, as shown in figure 5-4. Face frames are joined to cabinet ends with a butt, rabbeted, or mitered joint. The face frame must fit the case accurately, so doors and drawers may be installed easily at a later stage.

If flush doors are to be hung on the face frame, the frame is made about 1/16 inch thicker than the door to

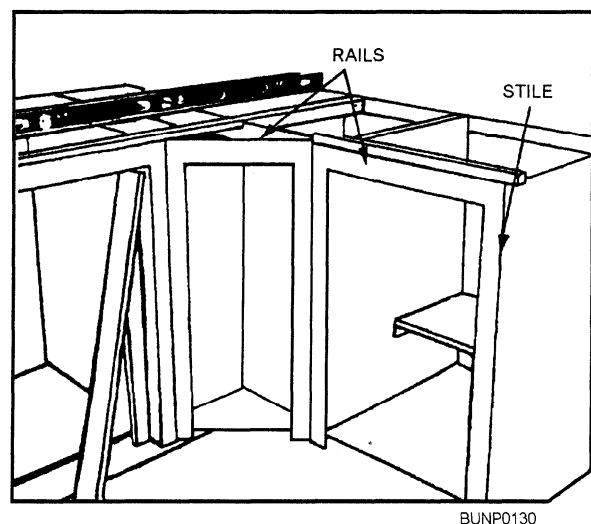


Figure 5-7.—Facing being placed on a cabinet.

be hung. This prevents the doors from binding against the door stops. If the end of the case is to be fitted against a wall, approximately 1/2 inch is added to the width of the stile on that end for scribing.

Doorstops are installed on the back side of the face all around the door openings if flush doors are to be hung. Doorstops project about 5/16 inch inside the opening and usually are made of thinner material than the face frame. They are applied with screws and glue because they take much abuse and a strong joint is needed.

Case Tops

The case top is installed according to its location. If it is above the line of vision, the top is cut in between the case ends, so the ends of the top are not visible. The top may also be lowered between the case ends. This provides clearance between the ceiling and the top of the case and also acts as a stop for the top ends of doors. If the top is below the line of vision, it is placed above the case ends.

In most cases, tops are fastened to the cabinet with screws driven up through the top of the skeleton frame.

Counter Tops

The standard kitchen counter top is 36 inches high, 25 inches deep, and 1 1/2 inches thick. This provides enough room for an average-size sink and ample working space on the surface. The counter top is held in place by driving screws up through the top frame of the base unit.

The counter top usually has a 3/4-inch overhang, made of plywood or particle board. It is doubled up by fastening a 2 1/2-inch-wide strip flush with the edges

and ends. This gives the appearance of a heavier counter top.

If a backsplash is used, it is usually 4 inches high. It has a 1/4-inch projection on the side that goes against the wall. This projection allows the installer to scribe the counter top to uneven wall surfaces. Prefabricated counter tops may be purchased and cut to any desired length. Special fasteners hold the lengths together.

DESIGNING CABINETS

The Builder should know the proper procedures and correct dimensions on how to build and install cabinets. There are two basic kinds of cabinets—the base unit and the wall unit. The base unit sets on the floor; the wall unit hangs on the wall.

The distance between the wall and base units is usually 16 to 18 inches. The distance is enough to accommodate most articles that are placed on counter tops, like coffee pots, toasters, blenders, and mixers. The top shelf in the wall unit should not be over 6 feet from the floor if it is to be in easy reach.

Base Unit

The height of the base unit must be 36 inches to the surface of the countertop. The width must allow for the 3/4-inch overhang of the counter top. Therefore, a standard base unit is usually 34 1/2 inches high by 24 1/4 inches deep. Toe space is provided beneath the base unit. The back edges of the end pieces project 1/4 inch beyond the cabinet back to allow for scribing.

Usually the base unit is constructed with drawers just below the counter top. The drawer opening height is 5 1/2 inches. Some base units contain all drawers or all doors (fig. 5-8).

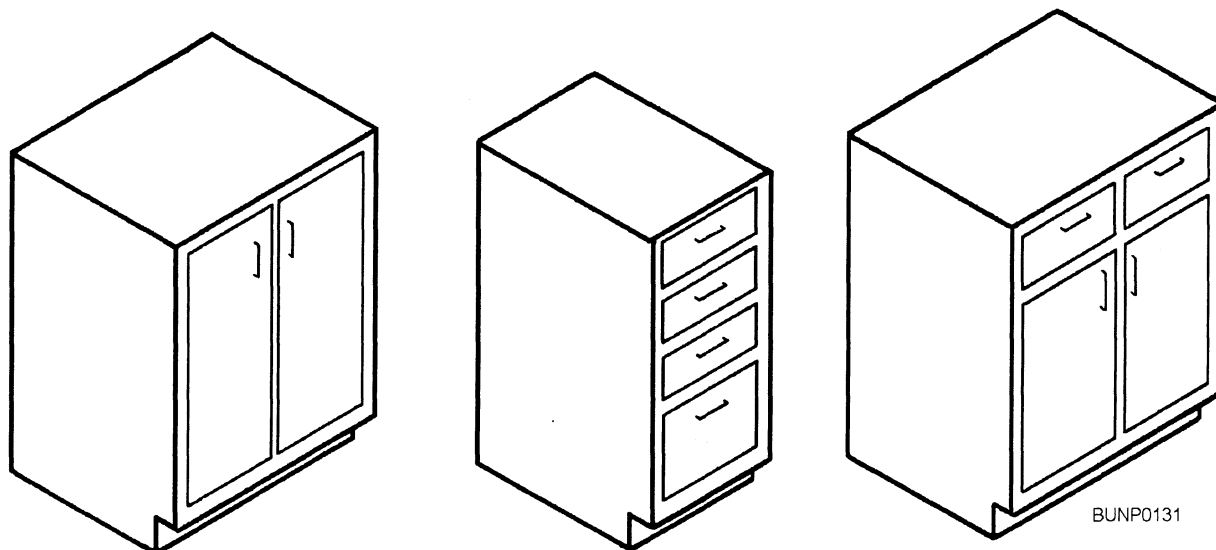


Figure 5-8.—Typical base units.

The base unit has a face frame and skeleton frame. A number of joints can be used to fasten the stiles and rails together, as shown in figure 5-9. The stiles are always mortised and the rails are always tenoned (fig. 5-10).

Wall Unit

A typical full-size wall unit is usually 12 inches deep and 30 inches high (fig. 5-11). A wall unit above a range is 18 inches high. Above a sink, it is 22 inches high, while over a refrigerator, it is only 15 inches high.

The number and spacing of shelves depend on the purpose of the cabinet. Shelves may be fixed or

adjustable. Shelves are usually spaced from 3 to 12 inches according to the customer's wishes.

The wall unit, like the base unit, has a face frame on which to fit and hang doors. These face frames are usually made of 1-inch by 2-inch solid lumber. The actual size is 3/4 inch by 1 1/2 inch.

An allowance is made on the back edges of the end pieces for scribing. Mounting strips must be included in the wall units. Screws are driven through these strips to hold the cabinet on the wall.

CONSTRUCTING A BASE UNIT

Earlier we covered the steps on how to plan a procedure before constructing a piece of cabinetry. The

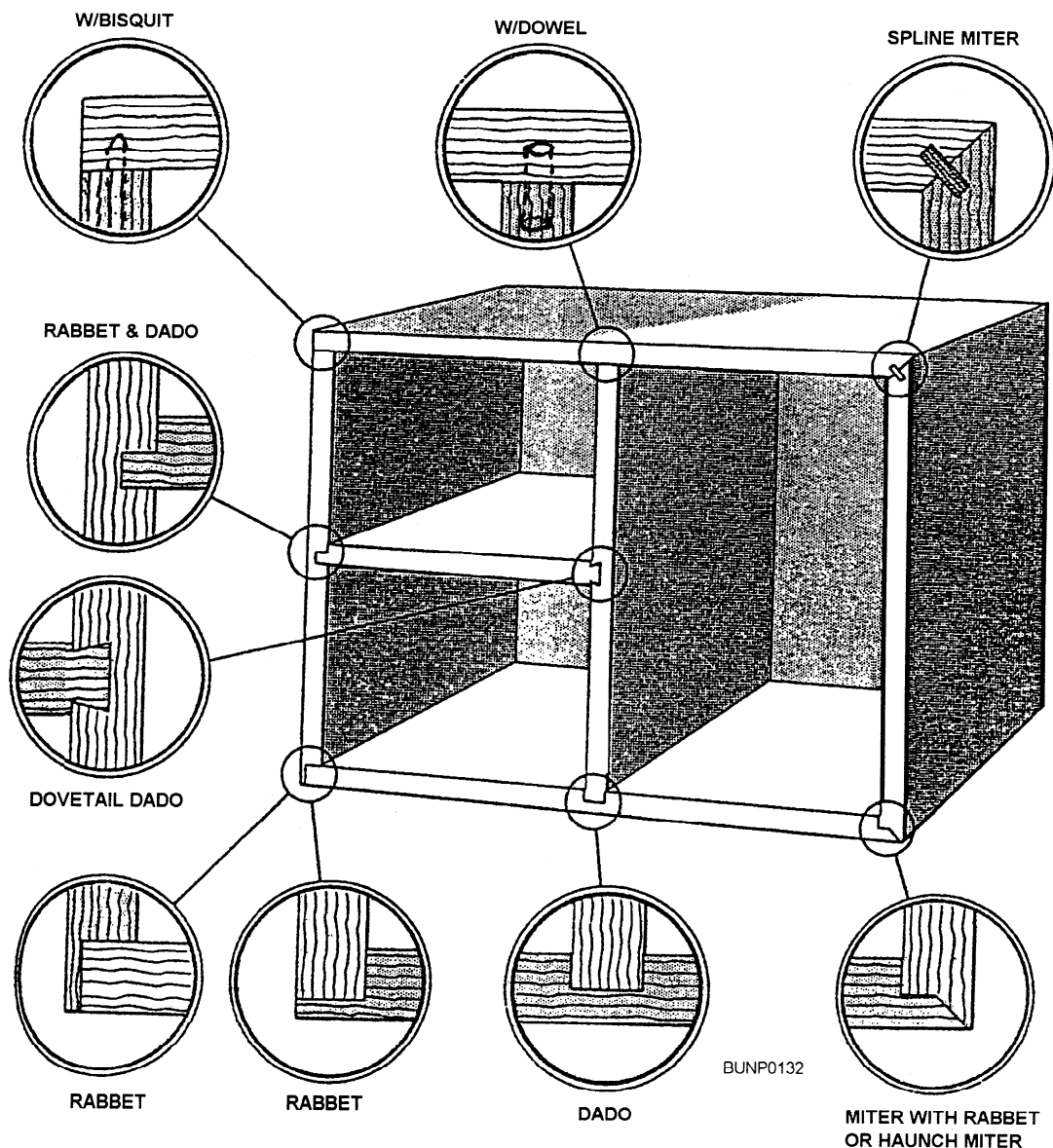


Figure 5-9.—Types of joints.

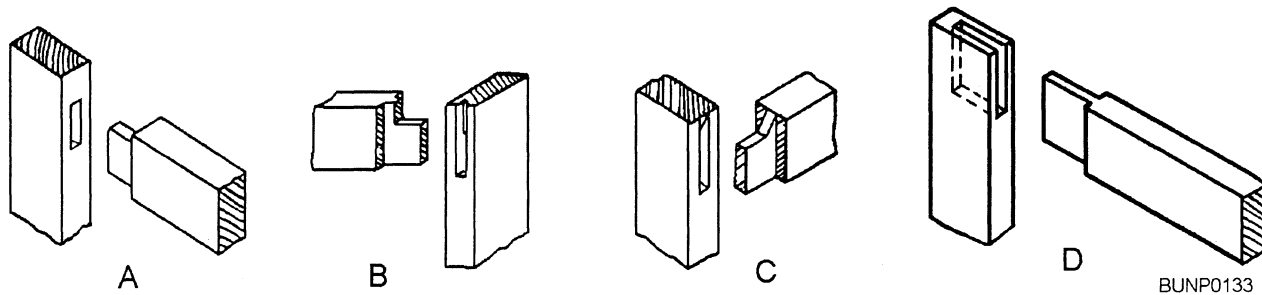


Figure 5-10.—Types of mortise-and-tenon joints.

following steps are a guide to constructing the base unit of a cabinet:

1. Review your drawings and specifications.
2. Select the lumber or plywood to be used; then develop a cutting list from the layout rod and/or drawing.
3. Determine the best joints to use on the face frame and the skeleton frame stiles and rails.
4. Cut out and assemble the face frame by gluing and clamping. After the glue has set, remove the clamps and sand both faces. You then set the frame aside.
5. For the base unit, cut out the skeleton frame similar to steps 3 and 4. Then cut a groove (dado) 1/4-inch wide by 1/2-inch deep on one edge of the four skeleton frame stiles.
6. Use a stub mortise-and-tenon joint 1/4-inch thick by 1/2-inch long on all the skeleton frame rails.
7. Layout the location of the rails on the stiles and assemble the skeleton frames by clamping and gluing. When they are dry, remove the clamps and set aside until needed.

8. Rabbet the back edges of the ends 1/2 inch by 1/2 inch. This rabbet will allow the end panels to project out beyond the plywood back for scribing the cabinet to the wall. Make sure the rabbet is cut from the inside face of the plywood, so the good face will show on the outside of the cabinet.

9. Lay out and cut the toe spaces on each end panel. The top of the cut is flush with the bottom rail of the face frame. The bottom of the cut is flush with the toeboard.

10. Cut out the toe spaces so that a right hand and left and end panel is obtained. Cut from the inside face to avoid splintering the face side.

11. Dado the inside of the end panels 3/16-inch deep and 3/4-inch wide for the bottom, shelf, and skeleton frame. Make a blind dado for the cabinet shelf.

12. Assemble the end panels, bottom, shelf, and skeleton frames with glue and clamps, finish nails, or screws. Make sure all edges line up.

13. Install the toeboard between the end panels by fastening with glue and finish nails through the end

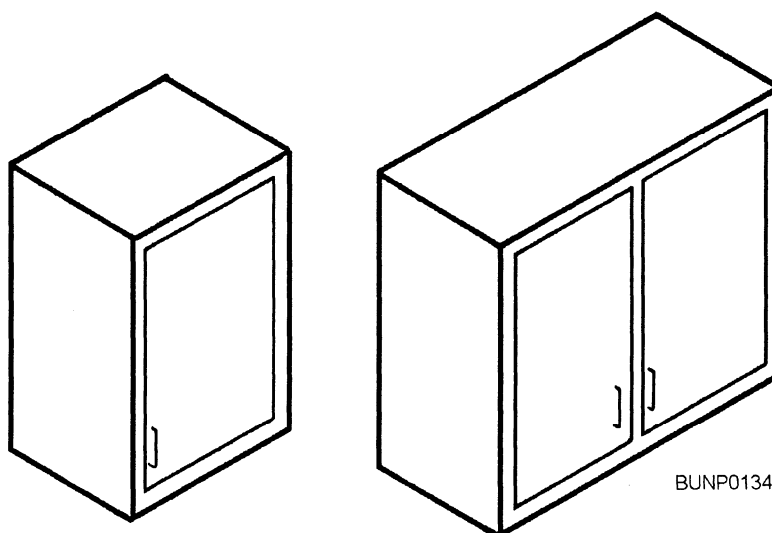


Figure 5-11.—Typical wall units.

panels and down through the case bottom. Remove any bow by keeping the toeboard the same distance from the front edge of the bottom all along its length.

14. The back helps hold the case rigid. The case must be absolutely square before fastening the back. Use the Pythagorean theorem to find the diagonals. This will square up the frame.

15. Fasten the back to the end panels, bottom, shelf, and skeleton frame. Straighten any bow when fastening.

16. Fasten the face frame to the front of the case. Keep the top edge of the bottom rails flush with the top surface of the case bottom and the outside stiles flush with the face of the case ends.

CONSTRUCTING A WALL UNIT

All the steps in constructing the base unit apply to constructing the wall unit. However, there are certain steps NOT needed, such as constructing toeboards, openings for drawers, and the installation of a counter top, which we will cover later in this chapter.

OTHER CONSTRUCTION METHODS

Cabinets are constructed in a number of different ways than those described in this unit. Construction depends on the quality desired, the time required, the materials used, and the experience of the craftsmen.

Cabinets may be made of hardwood, plywood, solid hardwood, or a combination of softwood, plywood, and solid softwood lumber. Often particle board is used, sometimes with a vinyl coating on one side to eliminate finishing the inside of the cabinet.

In many cases, the end panels are not dadoed to receive the interior pieces. Skeleton frames are eliminated. The end panels are then held together at the top by the back and face frames. Sometimes the back is not installed and a 1-inch by 3-inch or 1-inch by 4-inch strip is used between the ends at the top, flush with the back edge.

Members of the face frame in lesser quality work are butted against each other. They are fastened together with power-driven corrugated fasteners on the inside of the frame. In some cases, the bottom rail of the frame is eliminated. The front end of the bottom acts as the bottom rail of the face frame.

INSTALLING CABINETS

The cabinetmaker often is required to install kitchen and bathroom cabinets. Cabinets must be installed in a straight, level, and plumb line. This action requires skill because floors and walls are not level or plumb, especially in older buildings.

When cabinets are installed, many installers prefer to mount the wall units first, so work does not have to be done over base units. Let's cover the installation of a kitchen cabinet (fig. 5-12).

Wall Units

The first step in the installation of the wall unit is to locate the bottom of the wall unit (normally 52 inches); then measure up 52 inches from the lowest point of the floor. This usually leaves a 16-inch space between the counter top of the base unit and the bottom of the wall unit. Second, using a level and straightedge, draw a level line from the mark across the wall. The bottom of the wall units are installed to match this line.

Next, you need to locate the wall studs. When a stud is found, mark the location with a pencil; then measure 16 inches in both directions from the first mark to locate the next studs. Drive a finish nail to test for solid wood. If studs are not found at 16-inch intervals, then tap the wall with a hammer to locate each stud or use a stud finder.

At each stud, use a level and draw a plumb line down below the line for the bottom of the wall cabinets. Projecting below the wall units makes it easier to locate the studs when installing both wall and base units.

Then mount a temporary ledger board (1 by 2) to the wall along the bottom of the cabinet line. This action will help level and support the wall unit.

The following procedures are only a guide to installing the wall units:

1. Place the unit on the ledger board or a stand that holds it near the line of installation. If the unit is not level, use wood shims to bring the unit to level.

2. Test the front edge of the unit with a level for plumbness. If the unit is not plumb, shim it between the wall and its back edge with wood shims until it is plumb. If the unit is not plumb to the wall, you need to cut the back edge of the cabinet.

3. Scribe the back edge by riding a set of dividers against the wall and marking the back edge of both end panels to the contour of the wall.

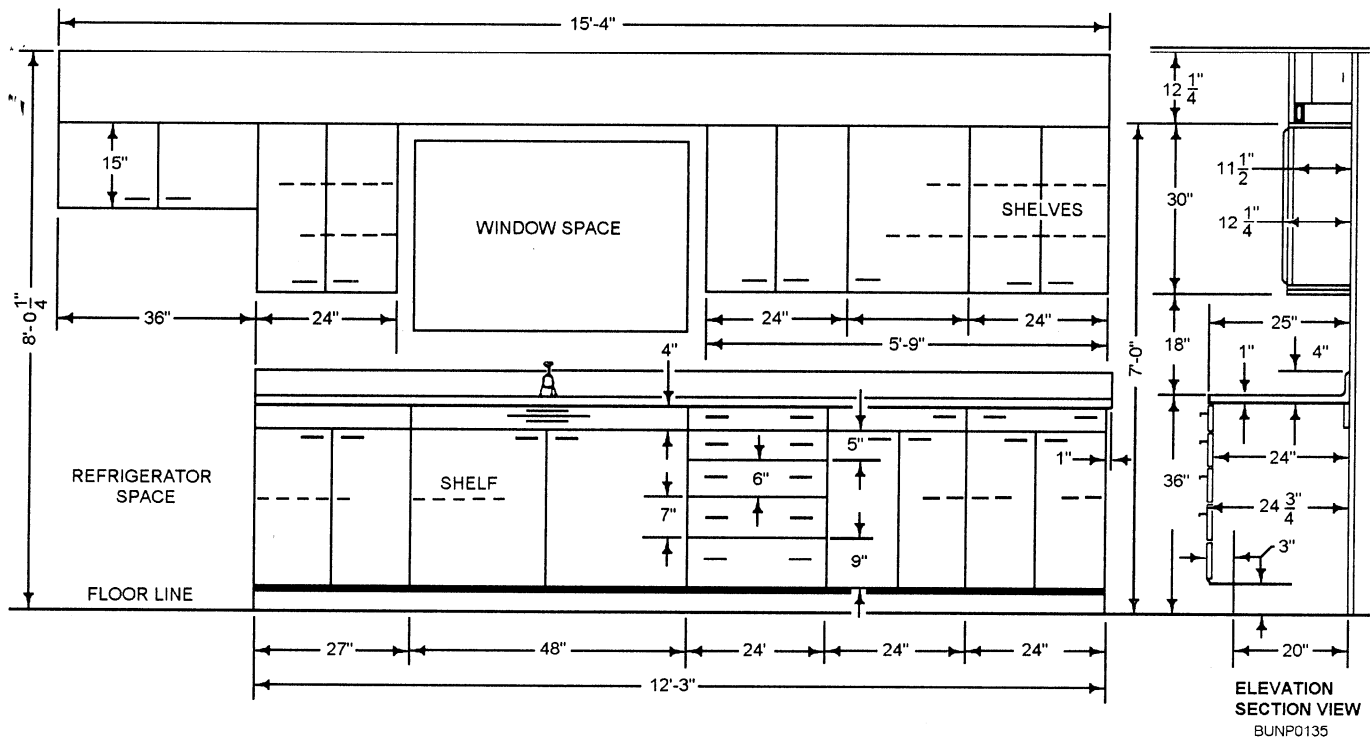


Figure 5-12.—Kitchen cabinet details.

4. Take the cabinet down off the ledger board; then cut the back edges with either a handsaw or a plane to the scribed line. Use a plane if you have to take off less than an 1/8 of an inch. Use a handsaw, rather than the saber or circular saw, because these saws cut on the upstroke and can splinter out the face side. The handsaw cuts on the downstroke which will not splinter the face.

5. Place the cabinet back into position; then fasten the cabinet into place with wood screws. Screws should be of sufficient length to hold the cabinet securely.

Adjacent cabinets are installed in the same manner. The back edges of these cabinets are scribed so their face frames are flush with the cabinet previously installed. Adjacent cabinets are fastened to each other by means of screws or bolts through the ends or through the stiles of the face frame.

Base Units

Before base cabinets are installed, draw a level line 16 inches plus the thickness of the countertop below the line previously drawn for the location of the wall units. This action will be the location of the top of the base units without the counter top. However, check your plans and specifications for the proper height on the counter top because it may vary.

1. First, locate and mark the location of all wall studs where the cabinets are to be hung. Find and mark the highest point in the floor. This action will ensure the base cabinet is level on uneven floor surfaces. (Shims should be used to maintain the cabinet at its designated leveled height.)

2. Start the installation of a base cabinet with a corner or end unit. After all base cabinets are in position, fasten the cabinets together. To get maximum holding power from screws, place one hole close to the top and one close to the bottom.

3. Starting at the highest point in the floor, level the leading edges of the cabinets. After leveling all the leading edges, fasten them to the wall at the studs to obtain maximum holding power.

Here are some helpful hints for the general construction of cabinets:

- Cabinet parts are fastened together with screws or nails. They are set below the surface, and the holes are filled with putty. Glue is used at all joints. Clamps should be used to produce better fitting glued joints.
- A better quality cabinet is rabbeted where the top, bottom, back, and side pieces come together. However, butt joints are also used. If panels are less than 3/4-inch thick, a reinforcing block

should be used with the butt joint. Fixed shelves are dadoed into the sides.

Screws should go through the hanging strips and into the stud framing. Never use nails. Toggle bolts are required when studs are inaccessible. Join units by first clamping them together and then, while aligned, install bolts and T-nuts.

Counter Tops

After the base units are fastened in position, the counter top is laid on top of the units and against the wall. Here are some helpful hints for installing counter tops:

1. Move the counter top, if necessary, so that it overhangs the same amount over the face frame of the base cabinets.
2. Adjust dividers for the difference between the amount of overhang and the desired amount of overhang. Scribe this amount on the backsplash if it has a scribing strip.
3. Cut the backsplash to the scribed line and fit it to the wall.
4. Fasten the counter top to the base cabinets with screws up through the top skeleton frame of the base units. Use a stop on the drill bit so you do not drill through the counter top.

In some cases, backsplashes are not built with scribing strips. To fit the backsplash to the wall, hold the counter top in the desired position. Press the backsplash against the wall at intervals and mark its outside face on the countertop. Remove the countertop and fasten the backsplash to the counter top on the marked lines. Fasten the counter top and backsplash in position.

Another method is to leave off the laminate on the face of the backsplash. Fasten the counter top in position. Hold the backsplash down tight on the counter top and nail it to the wall through its face. Then laminate the face of the backsplash on the job after it has been fastened in position. The disadvantage of this method is that it is difficult to remove the backsplash if the counter top has to be replaced.

DRAWERS

Builders use many methods of building drawers. The three most common methods are the multiple dovetail, lock-shouldered, and square-shouldered methods (fig. 5-13).

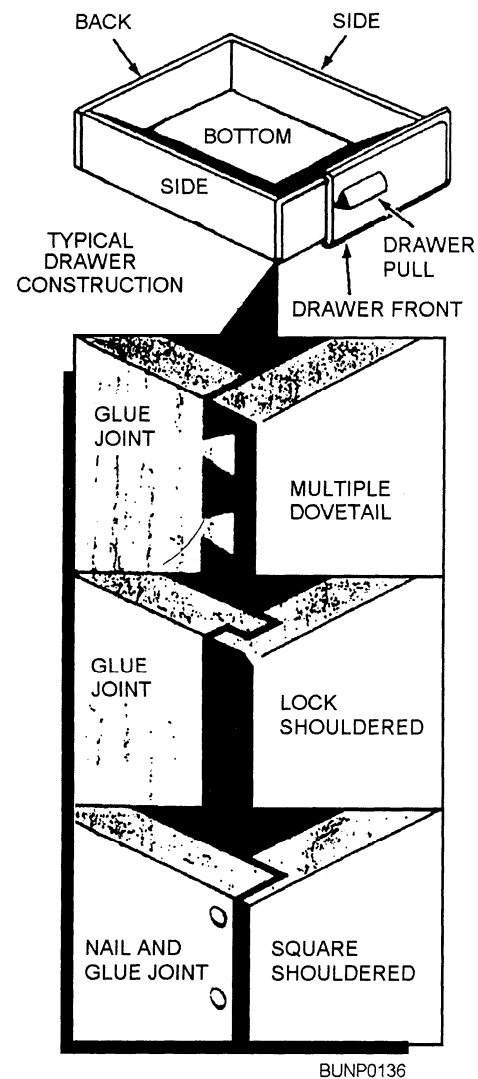


Figure 5-13.—Three common types of joints used in drawer construction.

Several types of drawer guides are available. The three most commonly used are the side guide, the corner guide, and the center guide, as shown in figure 5-14, view A.

The two general types of drawer faces are the lip and flush faces, as shown in figure 5-14, view B. A flush drawer must be carefully fitted. A lip drawer must have a rabbet along the top and sides of the front. The lip style overlaps the opening and is much easier to construct.

Drawer dimensions are usually given as width, height, and depth, in that order. The width of the drawer is the distance across the drawer opening. The height is the vertical distance of the opening. The depth is the distance from the front to the back.

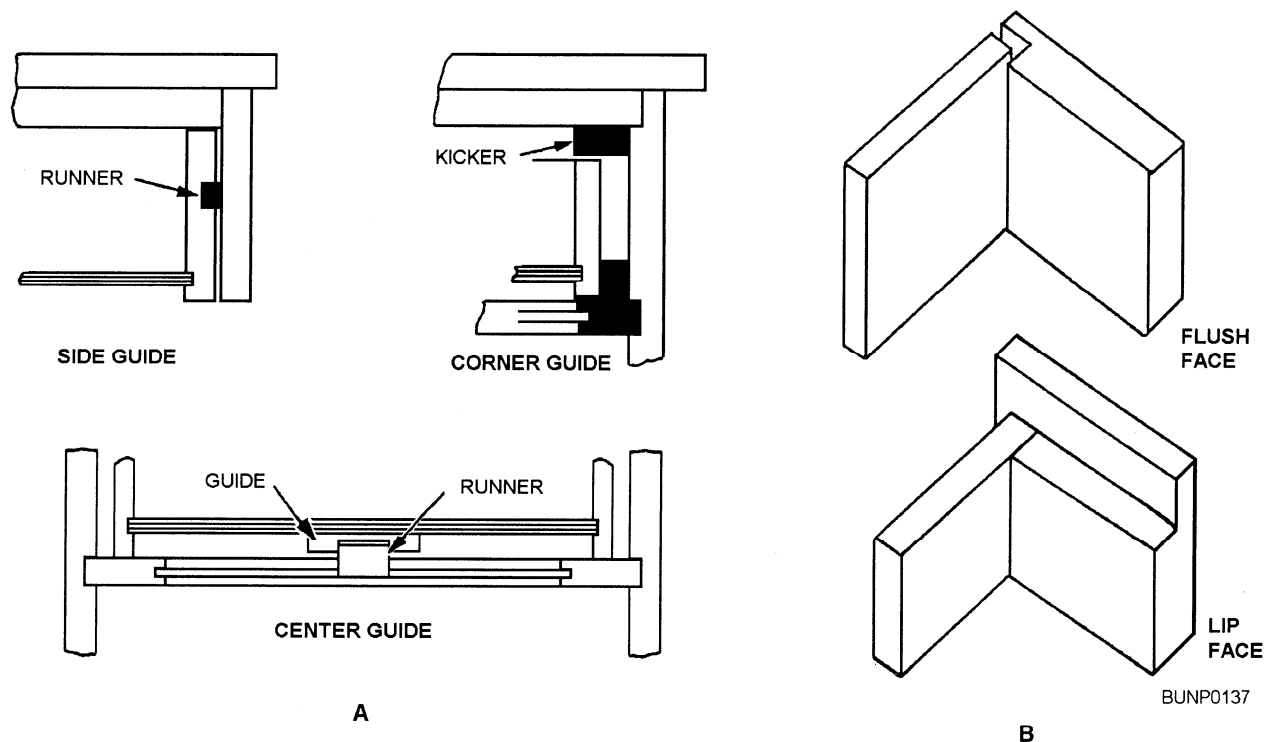


Figure 5-14.—Types of drawer guides (view A) and faces (view B).

Usually drawer fronts are made of 3/4-inch plywood or solid wood. The design must be in keeping with the cabinet. Sides and backs are generally 1/2-inch-thick solid wood. Sides are made thicker if they are to be grooved for certain types of drawer guides. The drawer bottom is usually made of 1/4-inch plywood or hardboard. Smaller drawers may have 1/8-inch hardboard bottoms.

CABINET DOORS

The four types of doors commonly used on cabinets are the flush (inset), lipped, overlay, and sliding doors.

A *flush door*, like the flush drawer, is the most difficult to construct. For a finished look, each type of door must be fitted in the cabinet opening within 1/16-inch clearance around all four edges. A *lipped door* is simpler to install than a flush door since the lip, or overlap, feature allows you a certain amount of adjustment and greater tolerances. The lip is formed by cutting a rabbet along the edge. *Overlay doors* are designed to cover the edges of the face frame. Several types of *sliding doors* are used on cabinets. One type of sliding door is rabbeted to fit into grooves at the top and bottom of the cabinet. The top groove is always made to allow the door to be removed by lifting it up and pulling the bottom out.

Door Construction

Doors are constructed as solid, flexible, folding, or paneled doors.

Solid doors are made of plywood, hardboard, particle board, or glued-up solid lumber. Designs are often grooved into the door with a router, or molding may be applied to give the door a more attractive appearance.

Flexible doors are made of thin strips glued together on a canvas back or held together with special edge joints. They are used on roll-top desks and other cabinets when the door must slide around a corner.

Paneled doors have an exterior framework of solid wood and a center containing one or more panels. The panels may be solid wood, plywood, hardboard, metal, plastic, glass, or some other material and come in many different designs. The exterior framework can be shaped in a number of ways also.

Door Installation

Cabinet doors can be installed as overlay, lipped, flush, and sliding. *Overlay doors* cover the opening, usually by 3/8 inch on all sides, and swing on overlay hinges. *Lipped doors* are rabbeted over the opening and swing on offset hinges. *Flush doors* fit inside the

opening and swing on either surface hinges or butt hinges, *Sliding doors* roll on tracks of metal or plastic.

HINGES

Hinges are made in many styles and shapes. If the kind of hinge is not specified, select a design that blends well with the cabinet being constructed. Some types of hinges are the surface, butt, offset, semiconcealed, pivot, piano hinge, and the new European-style hinge.

The *surface hinge* mounts on the exterior surface of the door and frame. It is made straight for flush doors or offset for lipped doors. This type of hinge is used when it is desirable to show the hardware, such as early American furniture.

The *butt hinge* is used on flush doors when little hardware must show. When it is installed, only the pin of the butt hinge shows when the door is closed. These hinges require a little extra time to install. It is recommended that you recess or mortise the hinge into the wood.

The *offset hinge* is used on lipped doors that are made from plywood. The offset hinge comes in various sizes to match the thickness of the plywood and the offset hinge must be mortised, rather than surface-mounted.

The *semiconcealed hinge* is designed for lipped and overlapping doors. This hinge has one leaf exposed on the face of the cabinet and the offset leaf is mortised into the door. Before the door is rabbeted, check the hinge to ensure that you rabbet the door to the proper depth.

The *pivot hinge* is used on overlay doors. It is fastened to the top and bottom of the door and to the inside of the case. It is used frequently when there is no face frame on the case. The doors completely cover the face of the case.

The continuous or *piano hinge* is a one-piece hinge that usually extends the whole length of the door. It is installed like a butt hinge, and only the hinge pin is exposed. This type of hinge is used when the door is subjected to heavy use.

The *European hinge* can be used on overlay or flush doors and is an excellent hinge used for frameless cabinets. This hinge has two leaves—the hinge cup leaf and the adjustable leaf. The hinge cup fits into a 1 3/8-inch hole (use a forstner bit to drill hole) on the cabinet door. The other leaf is screwed to the side panel of the cabinet. This leaf has an oval adjustment screw that allows the hinge to adjust up and down while the

center mechanism adjustment has two screws that adjust the hinge left and right.

The number and size of hinges depend on the dimensions of the door. There are two rules to follow: First, on any door that is longer than 2 feet, install three hinges; second, the total length of the hinges should equal at least one sixth of the length of the hinged edge. For example, if the door is 24 inches in height, use two 2-inch hinges; if the door is 34 inches, use three 2-inch hinges. When only two hinges are required, they are usually placed one quarter of the way from the top and bottom of the door. When three hinges are required, install the first hinge in the center and the other two hinges are placed 4 to 5 inches from the top and bottom.

CATCHES

Some hinges are self-closing; therefore, they eliminate the need for installing catches to hold the door closed. Others require catches. There are many kinds of catches available for holding doors.

Catches should be placed in the most out-of-the-way position possible. For instance, they are placed on the underside of shelves instead of on top.

Magnetic catches are used widely. They are available in single or double magnets of varying holding power. An adjustable magnet is attached to the inside of the case and a metal plate to the door. Other types of catches are the roller type and the friction type.

Elbow-type catches are used to hold one door of a double set. It must be released by reaching in back of the door. These are used when one of the doors is locked against the other.

Bullet catches are spring-loaded and fit into the edge of the door. When the door is closed, the catch fits into a recessed plate mounted on the frame.

LAMINATING COUNTER TOPS

In cabinetwork, the countertops are usually covered with a 1/16-inch layer of high-pressure plastic laminate. Although this material is very hard, it does not possess great strength and is serviceable only when it is bonded to plywood, particle board, or wafer wood. This base, or core material, must be smooth and is usually 3/4-inch thick.

Plastic laminate is a very tough material. It is widely used for surfacing counter tops, kitchen cabinets, and many other kinds of cabinetwork. It can be scorched by an open flame but resists heat, alcohol,

acids, and stains. Another advantage of plastic laminate is that no finishing is required. It also cleans easily with mild detergent.

Laminates are known by such trade names as *Formica*, *Micarta*, *Texolite*, *Wilson Art*, *Melamite*, and many others. They are manufactured in many colors and designs including many wood grain patterns. Surfaces are available in gloss, satin, textured, and other finishes. The distributor supplies samples or chips of the different colors and finishes to help the customer decide which to use.

Thicknesses

Generally two thicknesses of laminates are widely used: thick and thin.

Thick laminate is about 1/16-inch thick. It is used on horizontal surfaces, such as counter tops, tables, dressers, and desk tops.

Thin laminate is about 1/32-inch thick. It is used on vertical surfaces, such as the sides and front of kitchen cabinets. This is because vertical surfaces take less wear than horizontal surfaces. Thin laminate makes a more pleasing appearance because of the thin edge line it presents when trimmed. It is also less expensive than the thick laminate.

A thinner laminate, called backer laminate, is also available. It is used to cover the inside of doors and the underside of tabletops to give a balanced construction to the core.

Width and Lengths

Plastic laminate sheets come in widths of 24, 30, 36, 48, and 60 inches and lengths of 5, 6, 8, 10, and 12 feet. Sheets are usually 1 inch wider and longer than the size indicated.

Most distributors cut sheets in half through their width or length. This action increases the range of sizes. Since the material is relatively expensive, it is wise to carefully plan and order the most economical sizes.

Inspecting the Surface

Before a counter top is laminated, make sure all surfaces are flush. There should be no indentations where the pilot of the router bit will ride. Check for protruding nailheads and points. Plane or sand surfaces that are not flush. Fill in any holes and sand them smooth. Drive nailheads flush, fill, and sand.

Cutting Laminate to Rough Size

There are a number of ways to cut laminate. Whatever method is used, cut the pieces 1/4 to 1/2 inch wider and longer than the surface to be covered. Laminate must be handled carefully, because it is very brittle. It may crack if dropped or handled roughly.

One method of cutting laminate is to use a straightedge and a router with a flush trimming bit. This method is used frequently by installers on the job and in the shop. It is easier to run the cutting tool across a larger sheet than to move a large sheet across the cutting tool. Also, the router bit leaves a smooth edge.

The table saw can produce a smooth edge, cut with a 60-tooth, triple-chip carbide blade. Laminate may also be cut with a portable circular saw, saber saw, or band saw. However, these tools will not give a clean, ship-free edge.

Working with Laminates

Plastic laminates can be cut to rough size with a table saw, portable saw, or saber saw. Use a fine-tooth blade, and support the material close to the cut. If no electrical power is available, you can use a finish handsaw or a hacksaw. When laminates are cut with a saw, place masking tape over the cutting area to help prevent chipping the laminate. Make cut markings on the masking tape.

Measure and cut a piece of laminate to the desired size. Allow at least 1/4-inch extra to project past the edge of the counter top surface. Next, mix and apply the contact bond cement to the underside of the laminate and to the topside of the counter top surface. **Be sure to follow the manufacturer's recommended directions for application.**

Adhering Laminates

Allow the contact bond cement to set or dry. To check for bonding, press a piece of waxed brown paper on the cement-coated surface. When no adhesive residue shows, it is ready to be bonded. Be sure to lay a full sheet of waxed brown paper across the counter top. This allows you to adjust the laminate into the desired position without permanent bonding. Now, you can gradually slide the paper out from under the laminate, and the laminate becomes bonded to the counter top surface.

Be sure to roll the laminate flat by hand, removing any air bubbles and getting a good, firm bond. After the

laminate is sealed to the counter top surface, trim the edges by using either a router with a special guide or a small, block plane. If you want to bevel the countertop edge, use a mill file.

ADHESIVES

Seabees use many different types of adhesives in various phases of their construction projects. Glues (which have a plastic base) and mastics (which have an asphalt, rubber, or resin base) are the two major categories of adhesives.

The method of applying adhesives, their drying time, and their bonding characteristics vary. Some adhesives are more resistant to moisture and to hot and cold temperatures than others.

SAFETY NOTE: Some adhesives are highly flammable; they should be used only in a well-ventilated work area. Others are highly irritating to the skin and eyes. ALWAYS FOLLOW MANUFACTURER'S INSTRUCTIONS WHEN USING ADHESIVES.

Glues

The primary function of glue is to hold together joints in millwork and cabinetwork. Most modern glues have a plastic base. Glues are sold as a powder to which water must be added or in liquid form. Many types of glue are available under brand names. A brief description of some of the more popular types of glue is listed below.

Polyvinyl resin, or white glue, is a liquid that comes in ready-to-use plastic containers. It does a good job of bonding wood together, and it sets up (dries) quickly after being applied. Because white glue is not waterproof, it should not be used on work that will be subjected to constant moisture or high humidity.

Aliphatic resin, or yellow carpenter's glue, is a liquid that comes in ready-to-use plastic containers. Yellow glue is somewhat stronger than white glue and is more resistant to moisture, lacquers, and solvents.

Urea resin is a plastic-based glue that is sold in a powder form. The required amount is mixed with water when the glue is needed. Urea resin makes an excellent bond for wood and has fair water resistance.

Phenolic resin glue is highly resistant to temperature extremes and water. It is often used for bonding the veneer layers of exterior grade plywood.

Resorcinol glue has excellent water resistance and temperature resistance, and it makes a very strong bond. Resorcinol resin is often used for bonding the wood layers of laminated timbers.

Contact cement is used to bond plastic laminates to wood surfaces. This glue has a neoprene rubber base. Because contact cement bonds very rapidly, it is useful for joining parts that cannot be clamped together.

Mastics

Mastics are widely used throughout the construction industry. The asphalt, rubber, or resin base of mastics gives them a thicker consistency. Mastics are sold in cans, tubes, or canisters that fit into hand-operated or air-operated caulking guns.

These adhesives can be used to bond materials directly to masonry or concrete walls. If furring strips are required on a wavy concrete wall, the strips can be applied with mastic, rather than by the more difficult procedure of driving in concrete nails. You can also fasten insulation materials to masonry and concrete walls with a mastic adhesive. Mastics can also be used to bond drywall (gypsum board) directly to wall studs. They can also be used to bond gypsum board to furring strips or directly to concrete or masonry walls. Because you don't use nails, there are no nail indentations to fill.

By using mastic adhesives, you can apply paneling with very few or no nails at all. Wall panels can be bonded to studs, furring strips, or directly against concrete or masonry walls. Mastic adhesives can be used with nails or staples to fasten ply-wood panels to floor joists. The mastic adhesive helps eliminate squeaks, bounce, and nail popping. It also increases the stiffness and strength of the floor unit.